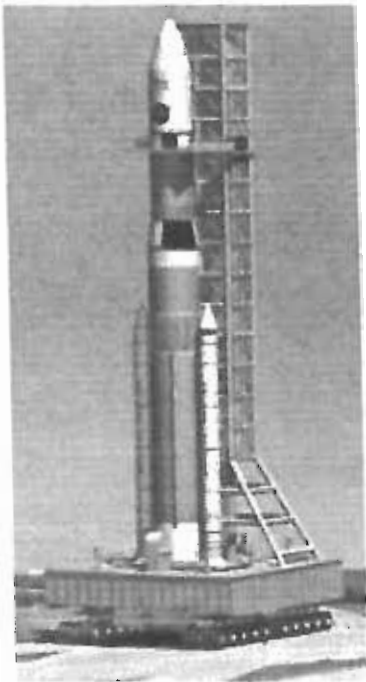




Kennedy Space Center
Center Operations Directorate

Constellation Commodities Studies Summary



Presented to:
Ground Hydrogen Symposium

By:
**Eric Dirschka, Hydrogen Program Engineer
NASA Propellants Management**

February 25, 2011
KSC Space Life Sciences Laboratory



Kennedy Space Center
Center Operations Directorate

Constellation Program

- ◆ (was) NASA's long-term program for space exploration
- ◆ Heavy-lift Ares V rocket was planned to have LH2 tanks about 2x the volume of the Shuttle.
 - LH2 losses during loading and scrub would likewise increase
 - Requirement to support 5 launch attempts in 5 days
 - 5x loading and scrub losses

Simply increasing the capacities of legacy methods will magnify inefficiencies/losses to gross levels



Kennedy Space Center
Center Operations Directorate

CxP Studies

◆ Goal

- Solicit industry expertise in production, storage, and transportation required for future use
- Improve efficiency and life cycle cost over legacy methods

◆ Objectives

- Consolidate KSC, CCAFS and other requirements
- Extract available industry expertise
- Identify commercial opportunities
- Synergy with State of Florida partnerships



Kennedy Space Center
Center Operations Directorate

What We Already Knew

◆ Improve the System

➤ Priority:

- Reduce Losses
- Losses that cannot be eliminated; capture and reuse
- Improve efficiency of Supply
- Improve Storage

➤ Interdependence of Parameters

- Example;
for a given launch campaign; reduced vehicle loading losses
reduces the required pad storage and required supply, which results
in reduced storage and delivery losses



Kennedy Space Center
Center Operations Directorate

Results (what industry told us)

- ◆ Challenging requirements
 - Launch campaigns and associated losses cause a large difference between high short-term demand versus long-term average
 - Direct opposition to steady-state 24/7 production
 - Large cryogenic storage tanks required to handle short-term requirements
 - Access restrictions and narrow delivery time windows
- ◆ Constructing on-site industry standard production plants, storage tanks and purchasing standard distribution equipment could save money over long-term.
- ◆ No cost cutting or efficiency improving technologies were identified or proposed.
- ◆ Several supply architectures compared; no clear winner



Results (cont'd)

◆ Lessons learned

- “Tight lipped” industrial gas companies
 - Little information on make-or-buy decision
 - Withhold details as proprietary until bidding on a funded project
- Industry logistics optimized for typical customers, not space launch customers
 - No new technologies revealed
- Future requirements too uncertain

◆ “Game changing” concept

- Polygeneration by a Public Utility Authority
- Utility would produce and deliver LH2, LN2, LO2, and electrical power